BRITISH STANDARD

BS EN
288-4 : 1992

Incorporating Amendment A1, not issued separately

Specification and approval of welding procedures for metallic materials

Part 4. Welding procedure tests for the arc welding of aluminium and its alloys

The European Standard EN 288-4 : 1992, together with its amendment A1, has the status of a British Standard

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Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee WEE/36, Approval testing of welding procedures and welders, upon which the following bodies were represented:

AEA Technology
Association of Consulting Scientists
British Constructional Steelwork Association Ltd.
British Iron and Steel Producers' Association
British Nuclear Fuels plc
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Process Plant Association
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Welding Manufacturers' Association (BEAMA Ltd.)

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Amendments issued since publication

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National foreword

This Part of BS EN 288 has been prepared by Technical Committee WEE/36, and is the English language version of EN 288-4 : 1992 *Specification and approval of welding procedures for metallic materials* Part 4: *Welding procedure tests for the arc welding of aluminium and its alloys*, incorporating amendment A1, published by the European Committee for Standardization (CEN). It supersedes BS 4870 : Part 2 : 1982 on 31 January 1993.

EN 288-4 and amendment A1 were prepared as a result of international discussions in which the UK took an active part.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled 'International Standards Correspondence Index', or using the 'Find' facility of the BSI Standards Electronic Catalogue.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 24, an inside back cover and a back cover.

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EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 288-4

February 1992

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June 1997

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English version

Specification and approval of welding procedures for metallic materials — Part 4: Welding procedure tests for the arc welding of aluminium and its alloys (includes amendment A1 : 1997)

Descriptif et qualification d'un mode opératoire de soudage sur les matériaux métalliques — Partie 4: Epreuve de qualification d'un mode opératoire de soudage à l'arc sur aluminium et ses alliages (inclut l'amendement A1 : 1997)

Anforderung und Anerkennung von Schweißverfahren für metallische Werkstoffe — Teil 4: Schweißverfahrensprüfungen für das Lichtbogenschweißen von Aluminium und seinen Legierungen (enthält Änderung A1 : 1997)

This European Standard was approved by CEN on 5 August 1992. Amendment A1 was approved on 1996-12-11. CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

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Foreword

This European Standard has been prepared by Working Group 1 'Specification and approval of welding procedures for metallic materials' of CEN/TC 121 'Welding'.

For this standard, ISO/TC 44/SC10N177 was considered and used as a basis. However, alterations were necessary due to the consideration of experience and updated knowledge.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by 1993-02, and conflicting National Standards shall be withdrawn at the latest by 1993-02.

In accordance with the Common CEN/CENELEC Rules, the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

Foreword of amendment A1

This amendment EN 288-4 : 1992/A1 : 1997 to EN 288-4 : 1992 has been prepared by Technical Committee CEN/TC 121, Welding, of which the secretariat is held by DS.

This Amendment to the European Standard EN 288-4 : 1992 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 1997, and conflicting national standards shall be withdrawn at the latest by December 1997.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Contents

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0 Introduction

All new welding procedure approvals are to be in accordance with this standard from the date of this issue.

However, this standard does not invalidate previous welding procedure approvals made to former national standards or specifications providing, the intent of the technical requirements is satisfied and the previous procedure approvals are relevant to the application and production work on which they are to be employed.

Also, where additional tests have to be carried out to make the approval technically equivalent, it is only necessary to do the additional tests on a test piece which should be made in accordance with this standard.

Consideration of previous procedure approvals to former national standards or specifications should be at the time of the enquiry or contract stage and agreed between the contracting parties.

1 Scope

This standard specifies how a welding procedure specification is approved by welding procedure tests.

It defines the conditions for the execution of welding procedure approval tests and the limits of validity of an approved welding procedure for all practical welding operations within the range of variables listed in clause **8**.

Tests shall be carried out in accordance with this standard unless more severe tests are specified by the relevant application standard or contract, when they shall be applied.

This standard applies to the arc welding of wrought aluminium and its weldable alloys according to EN 515 and EN 573-3 In this standard the term aluminium stands for aluminium and its alloys. The principles of this standard may be applied to other fusion welding processes subject to agreement between the contracting parties.

NOTE. Specific service, material or manufacturing conditions may require more comprehensive testing than is specified by this standard in order to gain more information and to avoid repeating the welding procedure test at a later date just to obtain additional test data.

Such tests may include:

– longitudinal weld tensile test;
– weld bend test or special bend test to measure elongation;
– Charpy V-notch impact test;
– 0,2 % proof stress;
– elongation;
– chemical analysis.

Arc welding is covered by the following processes in accordance with EN 24063:

131- metal-arc inert gas welding (MIG welding);
141- tungsten inert gas arc welding (TIG welding);
15 -plasma arc welding;
other fusion welding processes by agreement.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 287-2	*Approval testing of welders — Fusion welding — Part 2: Aluminium and aluminium alloys*
EN 288-1	*Specification and approval of welding procedures for metallic materials — Part 1: General rules for fusion welding*
EN 288-2	*Specification and approval of welding procedures for metallic materials — Part 2: Welding procedure specification for arc welding*
EN 515	*Aluminium and aluminium alloys — Wrought products — Temper designation*
EN 571-1	*Non destructive testing — Penetrant testing — Part 1: General principles*
EN 573-3	*Aluminium and aluminium alloys — Chemical composition and form of wrought products — Part 3: Chemical composition*
EN 895	*Destructive tests on welds in metallic materials — Transverse tensile test*
prEN 910	*Destructive tests on welds in metallic materials — Bend test*
prEN 970	*Non-destructive examination of fusion welds — Visual examination*
prEN 1321	*Destructive tests on welds in metallic materials — Macroscopic and microscopic examination of welds*
EN 24063	*Welding brazing, soldering and braze welding of metals — Nomenclature of processes and reference numbers for symbolic representation on drawings* (ISO 4063 : 1990)
EN 30042	*Arc-welded joints in aluminium and its weldable alloys — Fusion welding — Guidance on quality levels for imperfections* (ISO 10042 : 1992)
CEN CR 12187	*Welding — Guidelines for a grouping system of materials for welding purpose*
EN ISO 6947	*Welds — Working positions — Definitions of angles of slope and rotation* (ISO 6947 : 1990)

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3 Definitions

For the purpose of this standard, the definitions listed in Part 1 of this standard apply.

4 Preliminary welding procedure specification (pWPS)

The preliminary welding procedure specification shall be prepared in accordance with EN 288-2. It shall specify the tolerance for all the relevant parameters.

5 Welding procedure test

The making and testing of test pieces representing the type of welding used in production shall be in accordance with clauses **6** and **7** of this standard.

The welder who undertakes the welding procedure test satisfactorily in accordance with this standard is approved for the appropriate range of approval given in the relevant part of EN 287.

6 Test piece

6.1 General

The welded assembly to which the welding procedure will relate in production shall be represented by making a standardized test piece or pieces, as specified in **6.2**.

6.2 Shape and dimensions of test pieces

The test pieces shall be of a sufficient size to ensure a reasonable heat distribution.

In figures 1 to 4, t is the thickness of the thicker component part.

Additional test pieces, or longer test pieces than the minimum size, may be prepared in order to allow for extra and/or for re-testing specimens (see **7.5**).

If required by the application standard, the direction of working, e.g. extrusion, should be marked on the test piece.

The thickness and/or pipe outside diameter of the test pieces shall be selected in accordance with **8.3.2.1** to **8.3.2.4**.

Unless otherwise agreed, the shape and minimum dimensions of the test piece shall be as follows.

6.2.1 *Butt weld in plate*

The test piece shall be in accordance with figure 1. The length of the test piece shall be such as to provide for the appropriate test specimens as given in table 1.

6.2.2 *Butt weld in pipe*

The test piece shall be in accordance with figure 2. When small pipe diameters are used, several test pieces may be necessary.

NOTE. The word 'pipe', alone or in combination is used to mean 'pipe', 'tube' or 'hollow section'.

6.2.3 *Branch connection*

The test piece shall be in accordance with figure 3. The angle α is the minimum to be used in production.

A branch connection is considered as a fully penetrated joint (set-on or set-in or set-through joint).

6.2.4 *Fillet weld*

The test piece shall be in accordance with figure 3 or 4.

These may also be used with an edge preparation to give partial penetration.

6.3 Welding of test pieces

Preparation and welding of test pieces shall be carried out in accordance with the pWPS, and under the general conditions of welding in production which they shall represent. Welding positions and limitations for the angle of slope and rotation of the test piece shall be in accordance with EN ISO 6947.

If tack welds are to be fused into the final joint they shall be included in the test piece.

Welding and testing of the test pieces shall be witnessed by an examiner or examining body.

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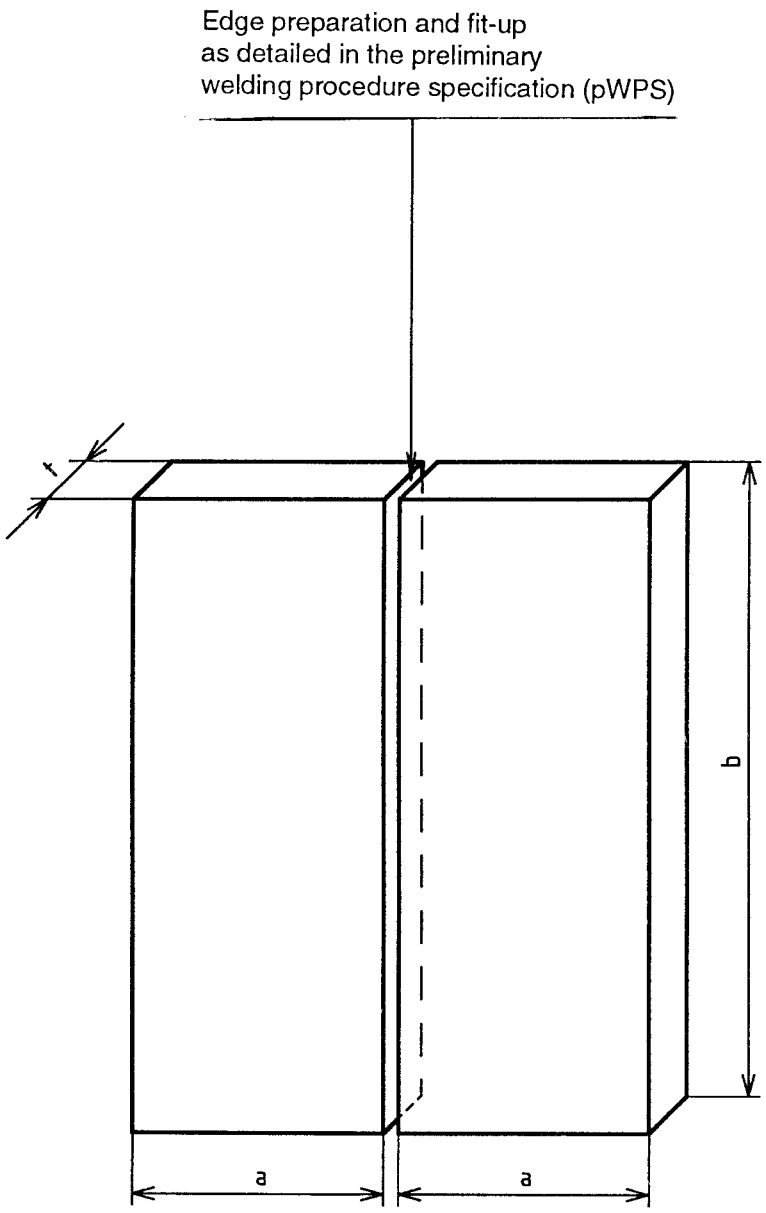

a = 3t; minimum value 150 mm

b = 6t; minimum value 350 mm

Figure 1. Test piece for a butt weld in plate

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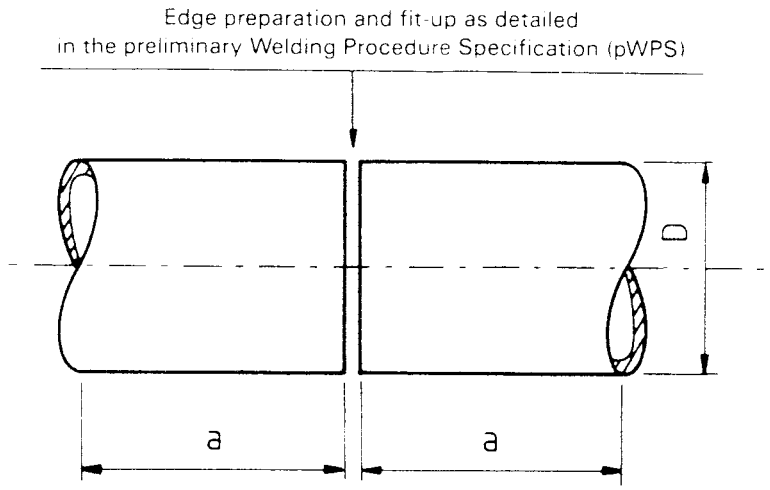

a = minimum value 150 mm

D = outside diameter

Figure 2. Test piece for a butt weld in pipe

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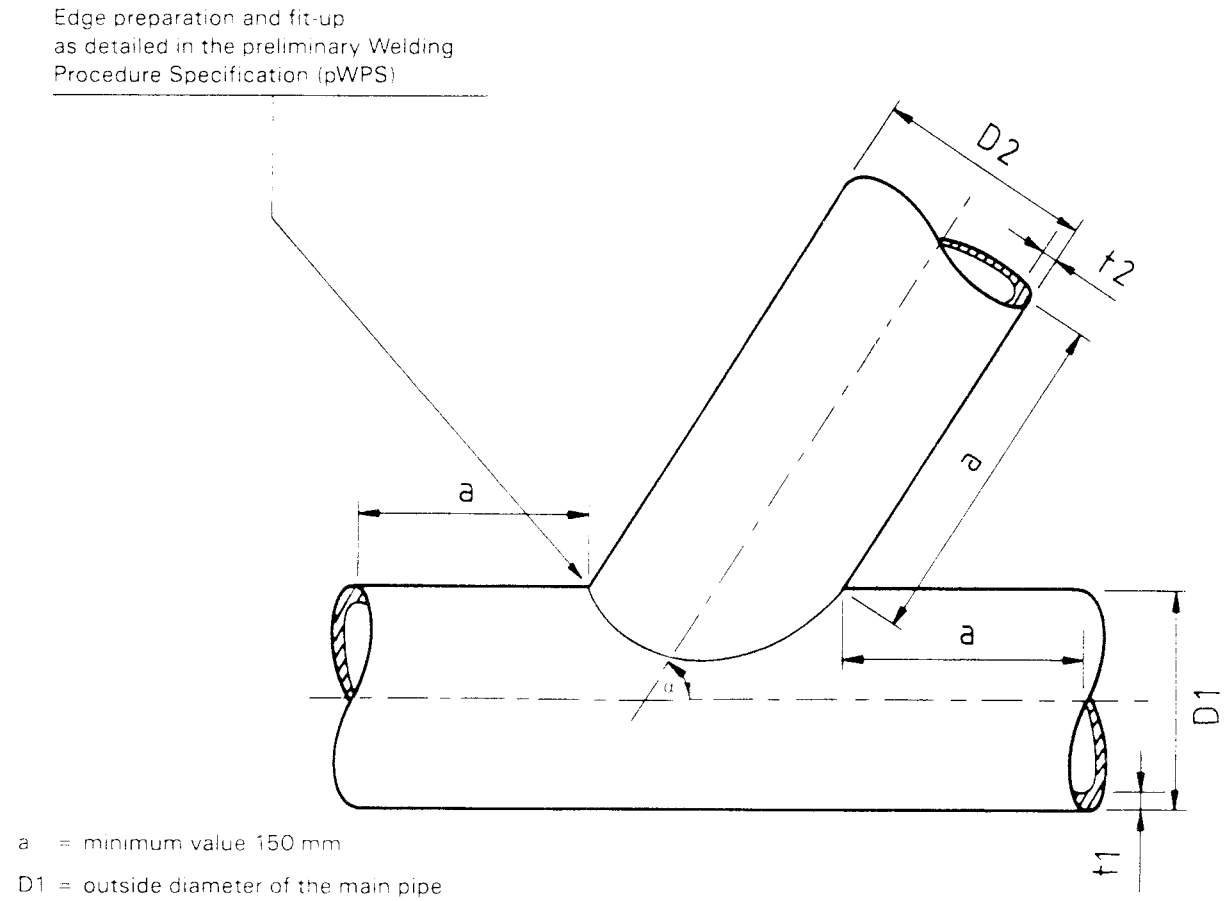

a = minimum value 150 mm

D1 = outside diameter of the main pipe

t1 = wall thickness of the main pipe

D2 = outside diameter of the branch pipe

t2 = wall thickness of the branch pipe

Figure 3. Test piece for a branch connection or a fillet weld on pipe

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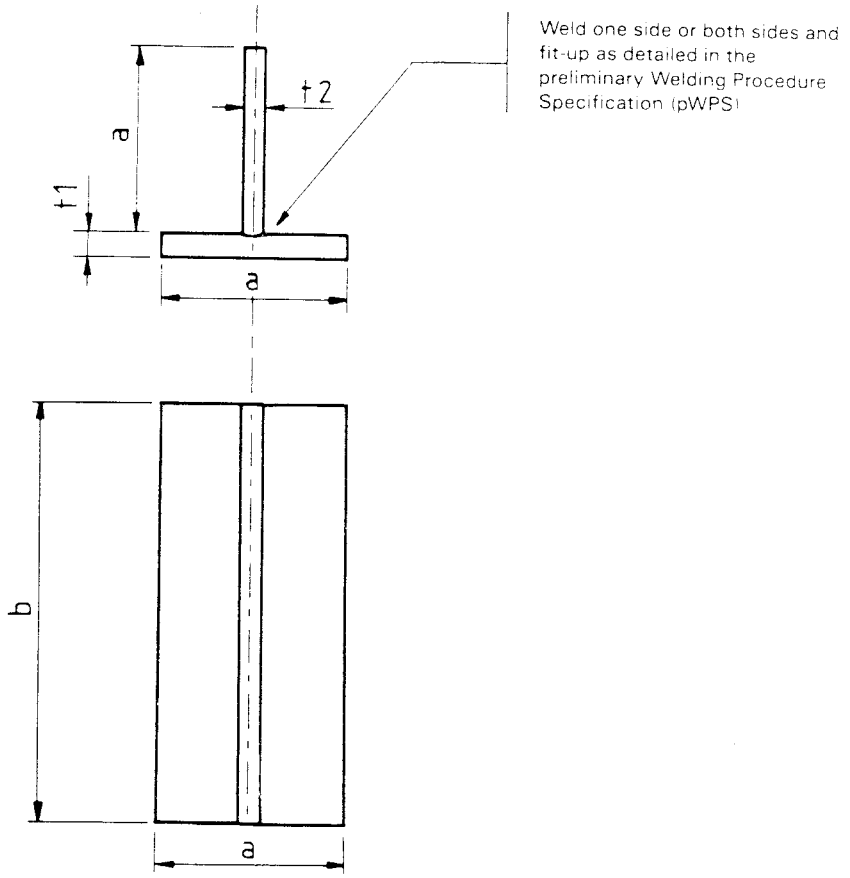

a = 3t ; minimum value 150 mm

b = 6t ; minimum value 350 mm

t1 and t2 = thicknesses of the plates

Figure 4. Test piece for a fillet weld on plate

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7 Examination and testing

7.1 Extent of testing

The testing includes both non-destructive examination (NDE) and destructive testing which shall be in accordance with the requirements of table 1.

7.2 Location and cutting of test specimens

The location of test specimens shall be in accordance with figures 5, 6, 7 and 8.

Test specimens shall be taken after NDE has shown satisfactory results. It is permitted to take the test specimens from locations avoiding areas showing acceptable imperfections.

Table 1 Examination and testing of the test pieces

Test piece	Type of test	Extent of testing	Note
Butt weld	Visual	100 %	–
figures 1 and 2	Radiographic or ultrasonic	100 %	–
	Penetrant test	100 %	5
	Transverse tensile test	2 specimens	–
	Transverse bent test	2 root and	–
		2 face specimens	1
	Macro-examination	1 specimen	–
	Micro-examination	1 specimen	2
Branch connection (3)	Visual	100 %	–
figure 3	Penetrant test	100 %	5
	Radiographic or ultrasonic	100 %	4
	Macro-examination	2 specimens	–
	Micro-examination	1 specimen	2
Fillet weld on plate (3)	Visual	100 %	–
figure 4	Penetrant test	100 %	5
Fillet weld on pipe (3)	Macro-examination	2 specimens	–
figure 3	Micro-examination	1 specimen	2

NOTE 1. 2 root and 2 face bent test specimens may be preferably substituted by 4 side bend test specimens for $t \geq 12$ mm.
NOTE 2. Only for material groups 22 and 23.
NOTE 3. Testing as detailed does not provide information on the mechanical properties of the joint. Where these properties are relevant to the application an additional approval shall also be held e.g. a butt weld approval.
NOTE 4. For outside diameter ≤ 50 mm no radiographic or ultrasonic test is required.

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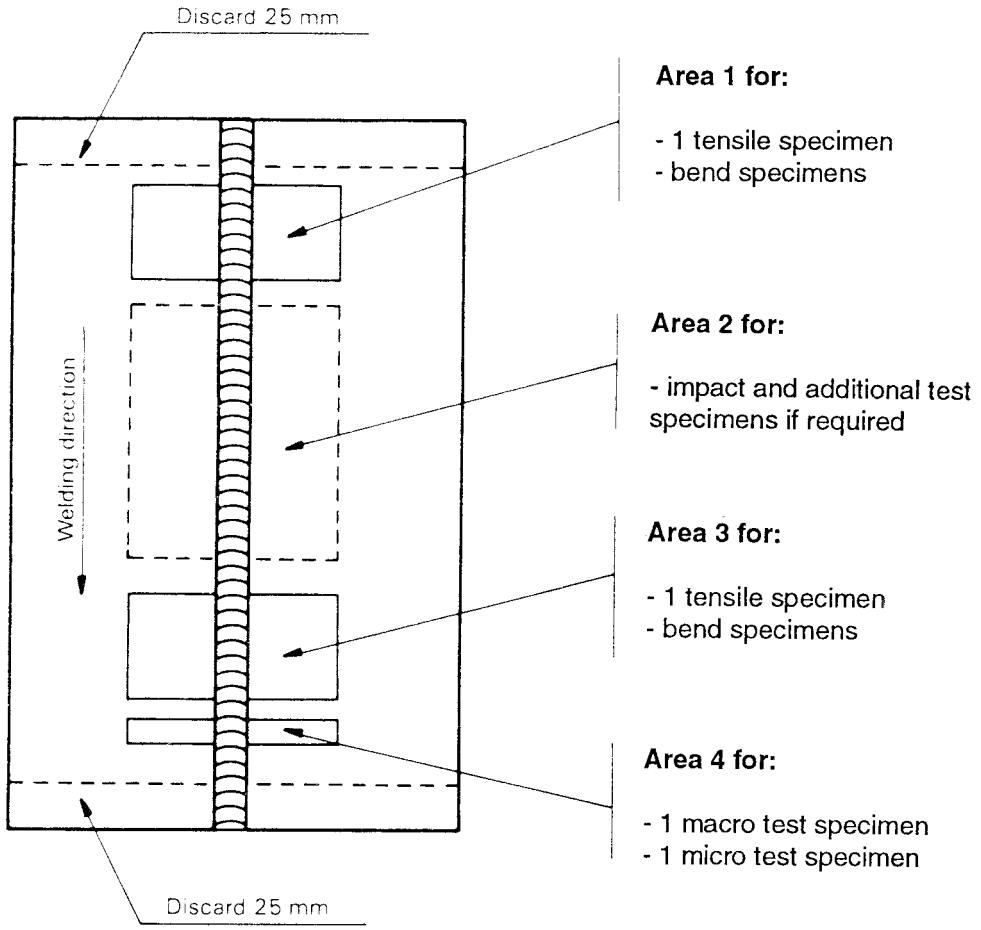

NOTE. Not to scale.

Figure 5. Location of test specimens for a butt weld plate

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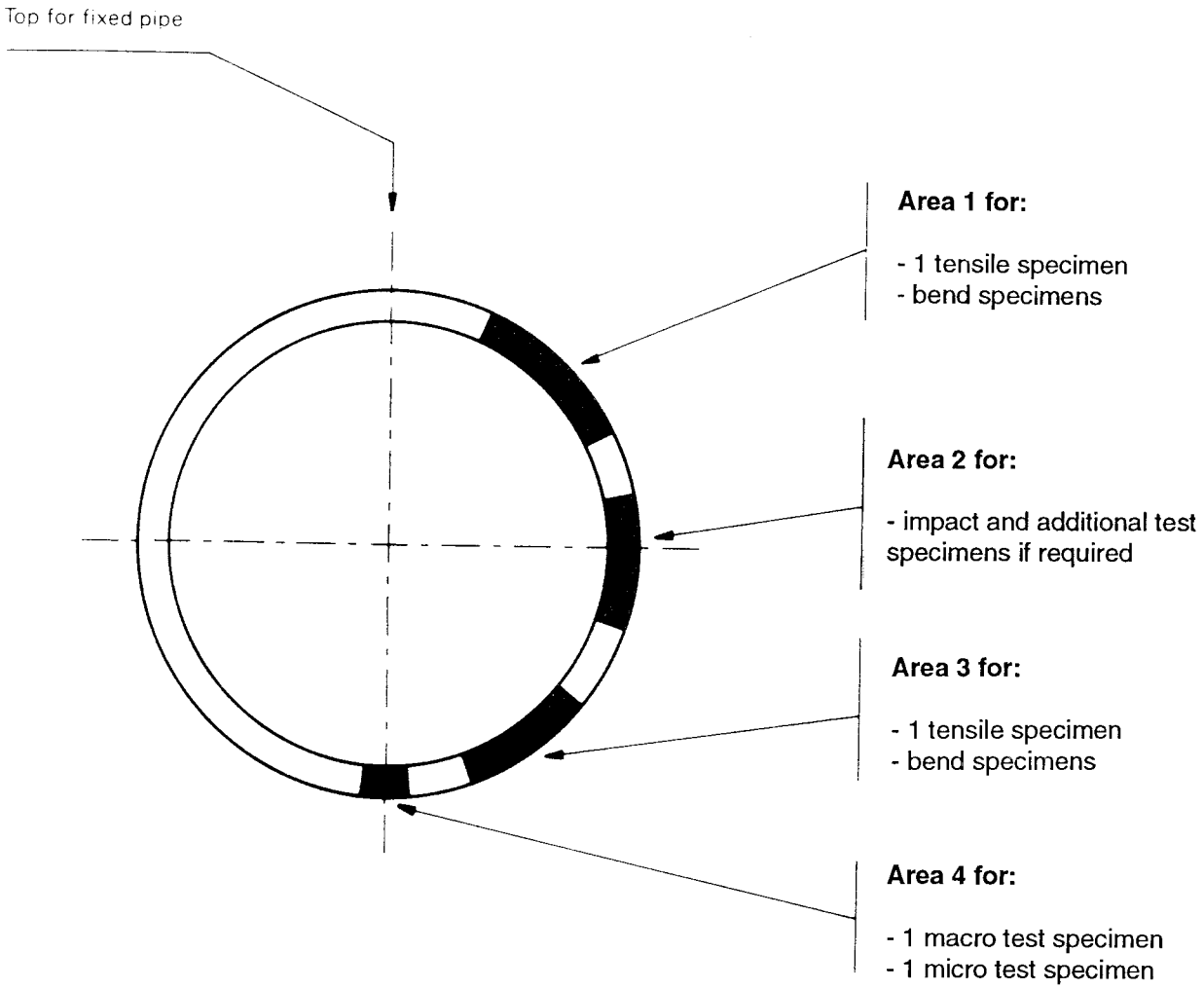

NOTE. Not to scale.

Figure 6. Location of test specimens for a butt weld in pipe

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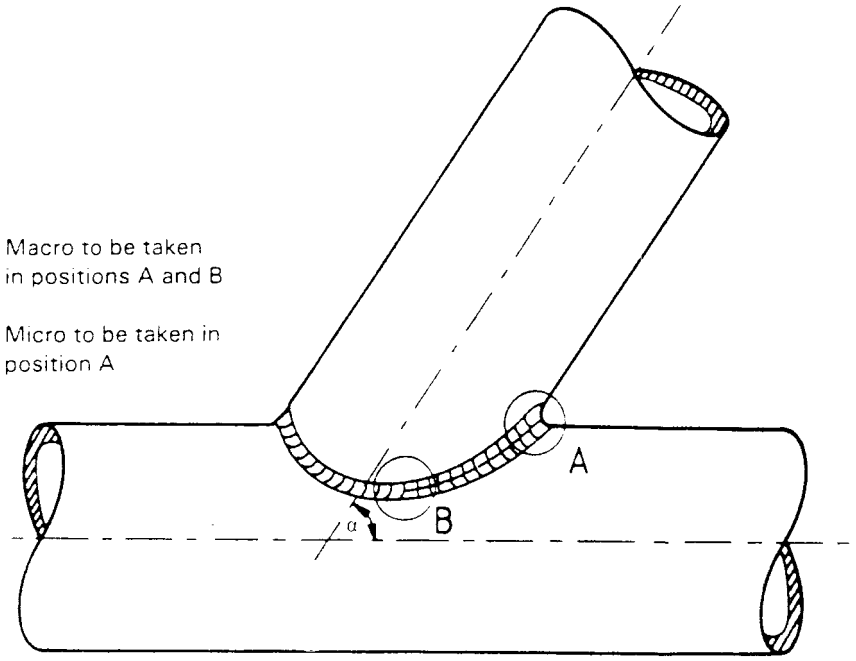

Figure 7. Location of test specimens for a branch connection or a fillet weld on pipe

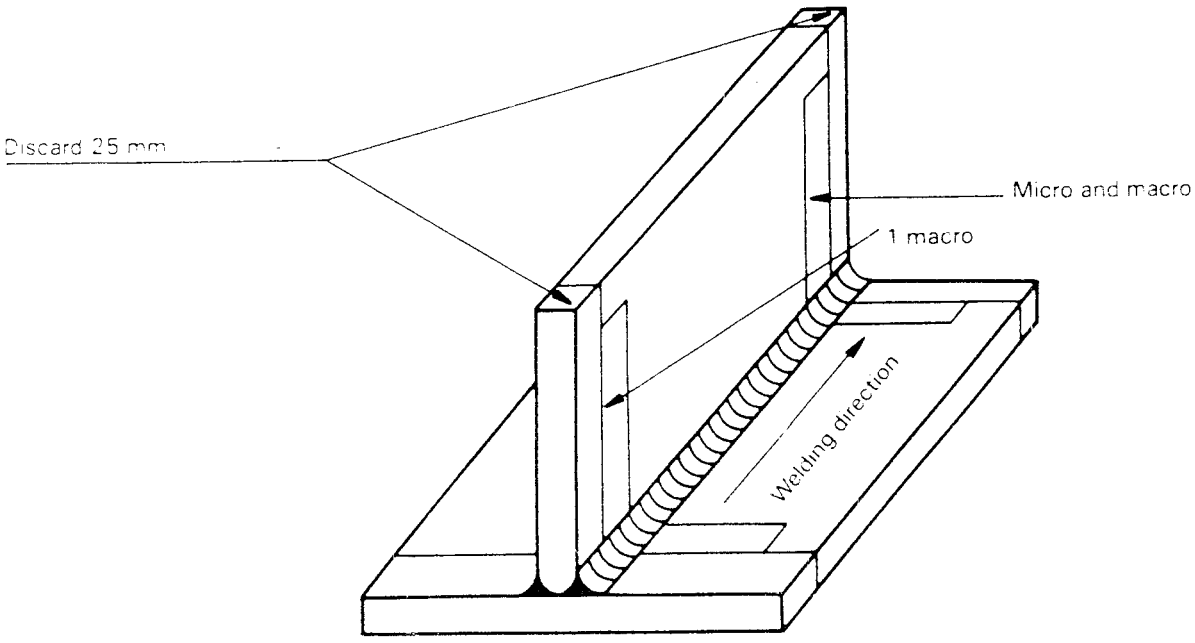

Figure 8. Location of test specimens for a fillet weld on plate

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7.3 Non-destructive examination

7.3.1 *Method*

After any required post-weld heat treatment, natural or artificial ageing and prior to the cutting of test specimens, all test pieces shall be examined visually and non-destructively in accordance with **7.1**.

Depending upon joint geometry, materials and the requirements for work, the NDE shall be carried out in accordance with EN 970 (visual examination) and EN 571-1 (penetrant testing).

7.3.2 *Acceptance levels*

A welding procedure is approved if the imperfections in the test piece are within the specified limits of level B in EN 30042 except for imperfection types as follows: excess weld metal, excess convexity, excess throat thickness and excessive penetration, for which level C shall apply.

7.4 Destructive tests

7.4.1 *Transverse tensile testing*

Specimens and testing for transverse tensile testing for butt joint shall be in accordance with EN 895.

For pipes > 50 mm outside diameter, the excess weld metal shall be removed on both faces to give the test specimen a thickness equal to the wall thickness of the pipe.

For pipes ≤ 50 mm outside diameter, and when full section small diameter pipes are used, the excess weld metal may be left undressed on the inside surface of the pipe.

The tensile strength of the test specimen shall normally not be less than the corresponding specified minimum value for the parent metal, in the soft conditions for groups 21, 22.1, and 22.2, see table 2.

The tensile strength [R_m(w)] of the welded test specimen shall satisfy the following requirement:

$R_m(w) = R_m(pm) \times T$

where

R_m(pm) is the specified minimum tensile strength of the parent metal;

T is the joint efficiency factor.

Table 2. Efficiency for tensile strength of butt welds

Material group (see table 4)		**Temper/condition of parent metal before welding**[1) 2)]	**Post weld ageing**[3)]	$T = \frac{R_m(w)}{R_m(pm)}$
21		F O H12 H14 H16 H18 H19	—	1,0[4)]
22.1 and 22.2		H112 H22 H24 H26 H28 H29 H32 H34 H38 H39	—	1,0[4)]
23	Al-Mg Si alloys	T4	Natural	0,9
		T4	Artificial	0,7[5) 7)]
		T5-T6	Natural	0,6
		T5-T6	Artificial	0,7[7)]
	Al-Zn Mg alloys	T4	Natural	0,9
		T4	Artificial	0,75[5) 7)]
		T6	Natural	0,75
		T6	Artificial	0,75[7)]
Other alloys		T4 and T6	—[6)]	—[6)]

[1)] See EN 515.
[2)] For parent metal in the other tempers not shown in the table, R_m(w) shall be agreed between the contracting parties.
[3)] See **7.3.1**.
[4)] R_m(pm) is based on the specified minimum tensile strength of the 'O' condition, irrespective of the actual parent metal temper used for the test.
[5)] When the test pieces are artificially aged after welding and prior to testing, the efficiency factor T applies to the T6 parent metal condition.
[6)] The post weld ageing conditions and R_m(w) shall be agreed between the contracting parties.
[7)] Higher properties may be achieved if post-weld full heat treatment is applied to group 23 alloys and R_m(w) shall be agreed between the contracting parties.

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7.4.2 ***Bend testing***

Specimens and testing for bend testing for butt joints shall be in accordance with EN 910.

For all groups the bend angle shall be 180° using the former diameter given in table 3.

During testing, the test specimens shall not reveal any one single flaw > 3 mm in any direction. Flaws appearing at the corners of a test specimen during testing shall be ignored in the evaluation.

For alloys of low ductility (group 22.2 and 23) there are two options:

a) The test specimens are annealed before testing and then apply the 'O' conditions in table 3, see **7.4.1**.

b) The test specimens are not annealed before testing and then apply the conditions in table 3 related to the appropriate temper.

7.4.3 ***Macro-examination***

The test specimen shall be prepared and etched in accordance with EN 1321 on one side to clearly reveal the fusion line, the HAZ and the build up of the runs.

The macro-examination shall include unaffected parent metal.

The acceptance levels stated in **7.3.2** shall apply.

7.4.4 ***Micro-examination***

The test specimen shall be prepared and etched in accordance with EN 1321 on one side to clearly reveal the fusion line, the structure of the weld metal and of the HAZ.

7.5 Re-testing

If the test piece fails to comply with any of the requirements for visual examination or NDE specified in **7.3.2**, one further test piece shall be welded and subjected to the same examination. If this additional test piece does not comply with the relevant requirements, the pWPS shall be regarded as not capable of complying with the requirements of this standard without modification.

If any test specimen fails to comply with the relevant requirements of **7.4** only due to weld imperfections, two further test specimens shall be obtained for each one that failed. These can be taken from the same test piece if there is sufficient material available or from a new test piece, and shall be subjected to the same test.

If either of these additional test specimens does not comply with the relevant requirements, the pWPS shall be regarded as not capable of complying with the requirements of this standard without modification.

Table 3. Former diameter of bend tests

Group of materials	**Former diameter**								
	Temper or condition (see EN 515)								
	O	F H112 H12 H22 H32	H14 H24 H34	H16 H26 H36	H18 H28 H38	H19 H29 H39	T4	T5-T6	T7
21	2*t*	3*t*	3*t*	3*t*	4*t*	4*t*	—	—	—
22.1	3*t*	3*t*	3*t*	4*t*	5*t*	5*t*	—	—	—
22.2	6*t*	6*t*	6*t*	6*t*	6*t*	6*t*	—	—	—
23	4*t*	—	—	—	—	—	6*t*	7*t*	8*t*

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8 Range of approval

8.1 General

All the conditions of validity stated below shall be met independently of each other.

Changes outside of the ranges specified shall require a new welding procedure test.

8.2 Related to the manufacturer

An approval of a WPS obtained by a manufacturer is valid for welding in workshops or sites under the same technical and quality control of that manufacturer.

8.3 Related to the material

8.3.1 *Parent metal*

8.3.1.1 *Grouping system*

In order to minimize the unnecessary multiplication of welding procedure tests, aluminium shall be grouped as shown in table 4.

The grouping is made in respect of the intentional added elements but not for fortuitous impurities.

A separate welding procedure approval shall be obtained for each material or material combination not covered by the grouping system.

Permanent backing material shall be considered as a parent metal.

Table 4. Grouping system for aluminium and its alloys

Group	Type of aluminium and aluminium alloys
21	Pure aluminium Pure aluminium ≤ 1,5 % impurities or alloy content
22	Non heat treatable alloys
22.1	Aluminium-magnesium alloys ≤ 3,5 % Mg
22.2	Aluminium-magnesium alloys with 4 % ≤Mg ≤ 5,6 %
23	Heat treatable alloys Aluminium-magnesium-silicon alloys and Aluminium-zirconium-magnesium heat treatable alloys which require controlled heat input and heat treatment or ageing after welding

8.3.1.2 *Dissimilar metal joints*

For dissimilar metal joints the range of approval is given in table 5.

Any dissimilar metal joint not covered by table 5, shall require a specific test with no range of approval.

Any material within one group gives approval for all other materials or combinations from the same group.

Table 5. Range of approval for dissimilar metal joints

Existing approved welding procedure test for group of aluminium	Range of approval
21	21 welded to 21
22.1	22.1 welded to 22.1
22.2 22.1	22.1 welded to 22.1 22.1 welded to 22.2 22.2 welded to 22.2
23	22.1 welded to 22.1 22.1 welded to 22.2[1)] 22.2 welded to 22.2[1)] 23 welded to 23

[1)] Provided that an Al-Mg alloy filler is used.

8.3.2 *Parent metal thickness and pipe diameter*

8.3.2.1 *General*

Nominal thickness t shall have the following meanings:

a) For a butt joint:

the parent metal thickness, which for joints between dissimilar thicknesses is that of the thinner material.

b) For a fillet weld:

the parent metal thickness approved for joints between different thicknesses is that of the thicker material. For each thickness range approved as in table 6 there is also an associated range of approved fillet weld throat thicknesses as given in **8.3.2.3**.

c) For a set-on branch connection:

the thickness of the branch pipe.

d) For a set-in or set-through branch connection:

the thickness of the main pipe.

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8.3.2.2 *Range of approval for butt welds*

The approval of a welding procedure test on thickness t shall include approval for thicknesses in the following ranges given in table 6.

Table 6. Range of approval for thickness

Dimensions in mm

Thickness of the test piece t[1)]	Range of approval	
	Butt, T-butt and branch connections for single run or single run from both sides	Butt, T-butt and branch connections for multi run and all fillet welds
$t \leq 3$	$0{,}8t$ to $1{,}1t$	t to $2t$
$3 < t \leq 12$	$0{,}8t$ to $1{,}1t$	3 to $2t$
$12 < t \leq 100$	$0{,}8t$ to $1{,}1t$	$0{,}5t$ to $2t$ (max. 150)
$t > 100$	$0{,}8t$ to $1{,}1t$	$0{,}5t$ to $1{,}5t$

[1)] For multi-process procedures, the recorded thickness contribution of each process may be used as a basis for the range of approval for the individual welding process.

8.3.2.3 *Range of approval for fillet welds*

In addition to the requirements of table 6, the range of approval of the throat thickness 'a' shall be 0,75a to 1,5a. However a test with a throat thickness $\geq$ 10 mm, shall give approval for all throat thickness $\geq$ 10 mm.

Where a fillet weld is approved by means of a butt weld test, the throat thickness range approved shall be based on the thickness of the deposited weld metal.

8.3.2.4 *Range of approval for the diameter of pipes and branch connections*

The approval of a welding procedure test on diameter D shall include approval for diameters in the following ranges given in table 7.

Table 7. Range of approval for pipe and branch connection

Diameter of the test piece D[1) 2)] mm	Range of approval
$D < 168{,}3$	$0{,}5\,D$ to $2\,D$
$D \geq 168{,}3$	$\geq 0{,}5\,D$ and plates[3)]

[1)] D is the outside diameter of the pipe or outside diameter of the branch pipe.
[2)] Approval given for plates also covers pipes when the outside diameter is > 500 mm.
[3)] See also **8.4.2**.

8.3.3 ***Angle of branch connection***

A procedure test carried out on a branch connection with angle α shall approve all branch angles α_1 in the range of $\alpha \leq \alpha_1 \leq 90^\circ$.

8.4 Common to all welding procedures

8.4.1 ***Welding process***

The approval is valid only for the welding process used in the welding procedure test. It is not permitted to change a multi run deposit into a single run (or single run on each side) or vice versa for a given process. In a multi-process procedure test the approval is only valid for the order used during the approval test.

NOTE. For multi-process procedures each welding process may be approved separately or in combination with other processes. Similarly one or more processes may be deleted from an approved WPS provided the joint thickness is within the approved thickness range of the relevant welding process(es) to be applied.

8.4.2 ***Welding positions***

The range of approval according to the welding position is given in table 8. In this table the range of approval is indicated in the same horizontal line.

8.4.3 ***Type of joint***

The range of approval for the types of welded joints used in the procedure test is given in table 9. In this table the range of approval is indicated in the same horizontal line.

8.4.4 ***Filler metal, classification***

The approval range of filler metals covers other filler metals within the same nominal chemical composition

8.4.5 ***Type of current***

The approval given is the type of current (AC, DC, pulsed current) and polarity used in the welding procedure test.

8.4.6 ***Heat input***

The requirements of this clause only apply when the control of heat input is specified.

The upper limit of heat input approved is 25 % greater than that used in welding the test piece.

The lower limit of heat input approved is 25 % lower than that used in welding the test piece.

8.4.7 ***Preheat temperature***

The lower limit of approval is the preheat temperature applied at the start of the welding procedure test.

8.4.8 ***Interpass temperature***

The upper limit of approval is the interpass temperature reached in the welding procedure test.

8.4.9 ***Post-weld heat treatment or ageing***

Addition or deletion of post-weld treatment or ageing is not permitted except that artificial ageing for group 23 gives approval for prolonged natural ageing.

The temperature range and ageing conditions specified in the pWPS is the range approved. Where required, heating rates, cooling rates, holding time and ageing time shall be related to the production component.

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Table 8. Range of approval according to welding position

Welding position for the test piece		Range of approval													
		Butt weld in plate					Butt weld in pipe				Fillet weld				
		PA	PC	PE	PF	PG	PA	PC	PF	PG	PA	PB	PD	PF	PG
Butt weld in plate	PA	*	–	–	–	–	×	–	–	–	×	–	–	–	–
	PC	×	*	–	×	–	–	–	–	–	×	×	–	×	–
	PE	×	×	*	×	–	–	–	–	–	×	×	×	×	–
	PF	×	×	–	*	–	–	–	–	–	×	×	–	×	–
	PG	–	–	–	–	*	–	–	–	–	–	–	–	–	×
PA only for rotated pipes	PA	×	–	–	–	–		–	–	–		–	–	–	–
Butt weld in pipe	PC	×	×	–	×	–	–	*	–	–	×	×	–	×	–
	PF	×	×	×	×	–	×	×	*	–	×	×	×	×	–
	PG	–	–	–	–	×	–	–	–	*	–	–	–	–	×
Fillet weld on plate and branch connection	PA	–	–	–	–	–	–	–	–	–	*	–	–	–	–
	PB	–	–	–	–	–	–	–	–	–	×	*	–	×	–
	PD	–	–	–	–	–	–	–	–	–	×	×	*	×	–
	PF	–	–	–	–	–	–	–	–	–	×	×	–	*	–
	PG	–	–	–	–	–	–	–	–	–	–	–	–	–	*

Key:
* indicates the welding position for which the WPS is approved in the approval test
× indicates those welding positions for which the WPS is also approved
– indicates those welding positions for which the WPS is not approved

NOTE. For symbols for welding positions, see ISO 6947.

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Table 9. Range of approval for type of joint

Type of joint in approval test piece			Range of approval							
			Butt welds in plate				Fillet weld on plate	Butt welds in pipe		Fillet welds on pipe
			Welded from one side		Welded from both sides			Welded from one side		
			with backing	no backing	with gouging	no gouging		with backing	no backing	
Butt weld in plate	Welded from one side	with backing	*	–	×	×	×	–	–	×
		no backing	×	*	×	×	×	–	–	×
	Welded from both sides	with gouging	–	–	*	×	×	–	–	×
		no gouging	–	–	–	*	×	–	–	×
Butt weld in pipe	Welded from one side	with backing	×	–	×	×	×	*	–	×
		no backing	×	×	×	×	×	×	*	×
Fillet weld	Plate		–	–	–	–	*	–	–	×
	Pipe		–	–	–	–	×	–	–	*

Key:
* indicates the weld for which the WPS is approved in the approval test
× indicates those welds for which the WPS is also approved
– indicates those welds for which the WPS is not approved

8.5 Specific to processes

8.5.1 *Process 131*

8.5.1.1 The approval given to the face and/or back shielding gas is restricted to the type of gas (nominal composition) used in the welding procedure test.

8.5.1.2 The approval given is restricted to the wire system used in the welding procedure test (e.g. single-wire or multiple-wire system).

8.5.2 *Process 141*

The approval given to the face and/or back shielding gas is restricted to the type of gas (nominal composition) used in the welding procedure test.

8.5.3 *Process 15*

8.5.3.1 The approval given is restricted to the type of plasma gas used in welding procedure test.

8.5.3.2 The approval given to the face and/or back shielding gas is restricted to the type of gas (nominal composition) used in the welding procedure test.

9 Welding procedure approval record (WPAR)

The welding procedure approval record (WPAR) is a statement of the results of assessing each test piece including re-tests. The relevant items listed for the WPS in Part 2 of this standard shall be included, together with details of any features that would be rejectable by the requirements of clause **7**. If no rejectable features or unacceptable test results are found, a WPAR detailing the welding procedure test piece results is approved and shall be signed and dated by the examiner or test body.

A WPAR format shall be used to record details for the welding procedure and the test results, in order to facilitate uniform presentation and assessment of the data.

An example of the WPAR-format is shown in annex A.

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Annex A (informative)

Welding Procedure Approval Record form (WPAR)

Welding procedure approval - Test certificate

Manufacturer's welding procedure Reference No.:

Examiner or examining body Reference No.:

Manufacturer:

Address:

Code/Testing standard:

Date of Welding:

Extent of Approval

Welding Process:

Joint Type:

Parent metal (s)

Metal Thickness (mm):

Outside Diameter (mm):

Filler Metal Type:

Shielding Gas/Flux:

Type of Welding Current:

Welding Positions:

Preheat:

Post-Weld Heat Treatment and/or ageing:

Other Information:

Certified that test welds prepared, welded and tested satisfactorily in accordance with the requirements of the code/testing standard indicated above.

Location Date of issue Examiner or examining body
Name, date and signature

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Details of weld test

Location:
Manufacturer's Welding Procedure
Reference No.:
WPAR No.:

Manufacturer:
Welder's Name:
Welding Process:
Joint Type:
Weld Preparation Details (Sketch)*:

Examiner or examining body

Method of Preparation and Cleaning:
Parent Material Specification:

Material Thickness (mm):
Outside Diameter (mm):
Welding Position:

Joint Design	**Welding Sequences**

Welding details

Run	**Process**	**Size of filler metal**	**Current** A	**Voltage** V	**Type of current/ polarity**	**Wire feed speed**	**Travel speed**[1)]	**Heat input**[1)]

Filler Metal Classification and trade name:
Any Special Baking or Drying:
Gas/Flux: shielding:
backing:
Gas Flow Rate: Shielding:
Backing:
Tungsten Electrode Type/Size
Details of Back Gouging/Backing:
Preheat Temperature:
Interpass Temperature:

Post-Weld Heat Treatment and/or Ageing:
Time, Temperature, Method:
Heating and Cooling rates*:

Other information*:
e.g. weaving (maximum width of run):
Oscillation: amplitude, frequency, dwell time
Pulse welding details:
Stand off distance:
Plasma welding details:
Torch angle:

Manufacturer
Name, date and signature

Examiner or examining body
Name, date and signature

* If required

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Test results

Manufacturer's Welding Procedure Reference No.:

Examiner or examining body Reference No.:

Visual Examination:

Penetrant/Magnetic Particle Test*

Tensile Tests

Radiography*:

Ultrasonic Examination*:

Temperature:

Type/No	R_e N/mm^2	R_m N/mm^2	A % on	Z %	**Fracture location**	**Remarks**
Requirement						

Bend Tests Former Diameter:

Type/No.	**Bend Angle**	**Elongation***	**Result**

Macro-examination:

Micro-examination*

Impact Test* Type: Size: Requirement:

Notch Location/Direction	**Temp.** °C	**Values** 1 2 3	**Average**	**Remarks**

Hardness Tests*

Type/load

Location of Measurements (Sketch*)

Parent Metal:

H.A.Z.:

Weld Metal:

Other Tests:

Remarks

Tests carried out in accordance with the requirements of:

Laboratory Report Reference No.:

Test results were acceptable/not acceptable (Delete as appropriate)

Test carried out in the presence of:

Examiner or examining body

Name, date and signature

concluded

---

* If required

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Annex B (informative)

Types of aluminium and its alloys according to the grouping system of table 4

Many of the alloys types listed in this annex refer to former national standards and are provided for information only.

CEN CR 12187 gives a list of aluminium and aluminium alloys up-to-date.

Table B.1 French grouping system according to AFNOR NF 50-451

Group	Parent materials	
21	1050 A : 99.5	3003 : A1-Mn 1 Cu
	1080 A : Al 99.8 A	
	1100 : Al 99.0 Cu	
22a	3004 Al-Mn 1 Mg 1	5005 : Al-Mg 1
	3005 : Al-Mn 1 Mn 1 Mg 0.5	5049 : Al-Mg 2 Mn
		5050 : Al-Mg 1.5
		5052 : Al-Mg 2.5
		5454 : Al-Mg 3 Mn
		5754 : Al-Mg 3
22b	5083 : Al-Mg 4 .5 Mn 0.7	
	5086 : Al-Mg 4	
23	6061 : Al-Mg 1 Si Cu	7020 : Al-Zn 4.5 Mg 1
	6081 : Al-Si 1 Mg	7075 : Al-Zn 5.5 Mg Cu
	6082 : Al-Si 1 Mg Mn	

Table B.2 United Kingdom grouping system according to BS 1470, BS 1474, BS 4300, BS 2898

Group	Parent materials
21	1050 A : Al 99.5
	1080 A : Al 98.8
	1200 : Al 99.0
	1350 : E-Al 99.5
	3103 : Al Mn 1
22a	3105 : Al Mn 0.5 Mg 0.5
	5005 : Al Mg 1
	5154 A : Al Mg 3.5
	5251 : Al Mg 2
	5454 : Al Mg 3 Mn
22b	5083 : Al Mg 4.5 Mn
23	6060 : Al Mg Si
	6061 : Al Mg 1 SiCu
	6063 : Al Mg 0.7 Si
	6063 A : Al Mg 0.7 Si (A)
	6082 : Al Si Mg Mn
	6061 A : E-Al Mg Si (A)
	6463 : Al Mg Si
	7020 : Al Zn 4.5 Mg 1

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Table B.3 Norwegian grouping system accor ding to NS 17.001

Group	Parent materials
21	1050 A : Al99,5
	1070 A : Al 99,7
	1100 : Al 99,0 Cu
	3003 : Al-Mn 1 Cu
22a	3004 : Al-Mn 1 Mg 1
	3005 : Al-Mn 1 Mg 0,5
	5005 : Al-Mg 1
	5049 : Al-Mg 2 Mn
	5052 : Al-Mg 2,5
	5054 : Al-Mg 3 Mn
	5754 : Al-Mg 3
22b	5083 : Al-Mg 4,5 Mn 0,7
	5086 : Al-Mg 4
23	6061 : Al-Mg 1 Si Cu
	6082 : Al-Si 1 Mg Mn
	7020 : Al-Zn 4,5 Mg 1
	7075 : Al-Zn 5,5 Mg Cu

Table B.4 Finnish grouping system according to SFS

Group	Parent materials
21	SFS 2580 : Al 99,8
	SFS 2581 : Al 99,7
	SFS 2582 : Al 99,5
	SFS 2883 : E-Al 99,5
	SFS 2584 : Al 99,0
	SFS 2585 : Al Mn 1
22a	SFS 2586 : Al Mg 1
	SFS 2587 : Al Mg 2,5
	SFS 2588 : Al Mg 3
22b	SFS 2589 : Al Mg 5
23	SFS 2590 : Al Si 5
	SFS 2591 : Al Mg Si
	SFS 2592 : E-Al Mg Si
	SFS 2593 : Al Si 1 Mg
	SFS 2596 : Al Zn 5 Mg 1

Table B.5 Switzerland grouping system according to SN 210 900

Group	AA	SN	ISO[1)]
21	1080 A	Al 99.8	Al 99.8 (A
	1050 A	Al 99.5	Al 99.5
	1200	A. 99.0	Al 99.0
	3103	Al Mn	Al Mn 1
22a	all 3 xxx alloys	Al Cu	Al Cu
	5005	Al Mg 1	Al Mg 1 (B)
	5052	Al Mg 2.5	Al Mg 2.5
	5754	Al Mg 3	Al Mg 3
	5454	Al Mg 2.7 Mn	Al Mg 3 Mn
22b	5086	Al Mg 4 Mn	Al Mg 4
	5083	Al Mg 4.5 Mn	Al Mg 4.5 Mn 0.7
23	6060	Al Mg Si 0.5	Al Mg Si
	6061	Al Mg 1 Si Cu	Al Mg 1 Si Cu
	6005 A	Al Mg Si 0.7	Al Si Mg (A)
	6082	Al Mg Si 1 Mn	Al Si 1 Mg Mn
	7020	Al Zn 4.5 Mg 1	Al Zn 4.5 Mg 1
	7075	Al Zn 6 Mg Cu 1.5	Al Zn 5.5 Mg Cu
	7022	Al Zn Mg Cu 0.5	—

[1)] ISO/DIS 209-1.

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Table B.6 Italian grouping system according to UNI

Group	Parent metal	UNI
21	1200 : Al 99,0	UNI 9001-1
	1050 A : Al 99,5	UNI 9001-2
	1070 A : Al 99,7	UNI 9001-3
	1080 A : Al 99,8	UNI 9001-4
	3003 : Al Mn 1,2 Cu	UNI 9003-1
22a	3004 : Al Mn 1,2 Mg	UNI 9003-2
	3005 : Al Mn 1,2 Mg 0,4	UNI 9003-4
	5005 : Al Mg 0,8	UNI 9005-1
	5050 : Al Mg 1,5	UNI 9005-7
	5052 : Al Mg 2,5	UNI 9005-2
	5151 : Al Mg 2,7 Mn	UNI 9005-3
	5154 B : Al Mg 3,5	UNI 9005-8
22b	5083 : Al Mg 4,5	UNI 9005-5
	5086 : Al Mg 4,4	UNI 9005-1
23	6061 : Al Mg 1 Si Cu	UNI 9006-2
	6082 : Al Mg Si 1 Mn	UNI 9006-4
	7020 : Al Zn 1,5 Mg	UNI 9007-1
	7075 : Al Zn 5,8 Mg Cu	UNI 9007-2

Table B.7 German grouping system according to DIN 1745

Group	Parent materials	
21	A1 99, 98 R	A1 Mn Cu
	A1 99,5	A1 Mn
	A1 99,7	
	A1 99,8	
22a	A1 Mn 1 Mg 1	A1 Mg Cu
	A1 Mn 1 Mg 0,5	A1 Mg 1,5
		A1 Mg 2,5
		A1 Mg 2 Mn 0,8
		A1 Mg 3
		A1 Mg 2,7 Mn
22b	A1 Mg 4 Mn	
	A1 Mg 4 Mn	
	A1 Mg Si 1 Mn	A1 Zn 4,5 Mg 1
	A1 Mg Si Cu	
	A1 Mg Si 0,7	

Table B.8 Austrian grouping system

Group	Parent materials	
21	Al 99,0	Al Mn Cu
	Al 99,5	Al Mn
	Al 99,7	
	Al 99,98	
22a	Al Mn 1 Mg 1	Al Mg 1
	Al Mn 1 Mg 0,5	Al Mg 1,5
		Al Mg 2,5
		Al Mg 3
		Al Mg 2 Mn 0,5
		Al Mg 2 Mn 0,8
		Al Mg 2,7 Mn
22b	Al Mg 4 Mn	
	Al Mg 4,5 Mn	
23	Al Mg Si 1 Mn	Al Zn 4,5 Mg 1
	Al Mg Si 0,5	
	Al Mg Si 0,7	
	Al Mg Si 0,9	

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List of references

See national foreword.

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